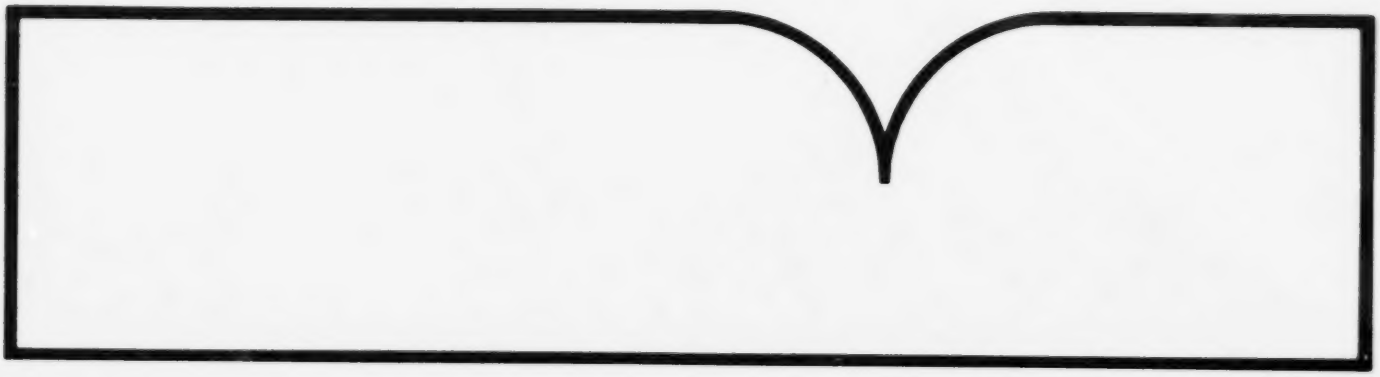
U.S. DEPARTMENT OF COMMERCE

PB80-170657

Evaluation of the Ram-Jet Device, a PCV Air Bleed

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Jan 80



U.S. Department of Commerce
National Technical Information Service
NTIS.

EPA-AA-TAEB-80-10

PB80-170657

Evaluation of the Ram-Jet Device, a PCV Air Bleed

January 1980

by

Edward Anthony Barth

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-AA-TAEB-80-10	2.
3. RECIPIENT'S ACCESSION NO. PB80 170657	
4. TITLE AND SUBTITLE: Evaluation of the Ram-Jet Device, a PCV Air Bleed	5. REPORT DATE: January 1980
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Edward Anthony Barth	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Environmental P tection Agency Office of Mobile Source Air Pollution Control Emission Control Technology Division Ann Arbor, MI. 48105	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Same as Box 9	13. TYPE OF REPORT AND PERIOD COVERED: Technical
	14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious potential benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy or both. EPA invites developers of such systems to provide complete technical data on the system's principle of operation, together with available test data on the system. In those cases for which review by EPA technical staff suggests that the data available shows promise or EPA is requested to test the device by other governmental agencies, attempts are made to schedule confirmatory tests at the EPA Motor Vehicle Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Test and Evaluation Reports, of which this report is one.

The Ram-Jet is a retrofit device marketed by Ed Almquist. It is designed to bleed in extra air to the engine by allowing ambient air to bypass the carburetor under high engine load conditions. The manufacturer claims the device reduces emission pollutants and improves fuel economy.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Emission Exhaust Gases Fuel Economy Air Pollution Tests	Ram-Jet Retrofit device Air Bleed devices	

18. DISTRIBUTION STATEMENT: RELEASE UNLIMITED	19. SECURITY CLASS *(This Report)*: UNCLASSIFIED	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)*: UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

Background

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious potential benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy or both. EPA invites developers of such systems to provide complete technical data on the system's principle of operation, together with available test data on the system. In those cases for which review by EPA technical staff suggests that the data available shows promise or EPA is requested to test the device by other governmental agencies, attempts are made to schedule confirmatory tests at the EPA Motor Vehicle Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Test and Evaluation Reports, of which this report is one.

The Ram-Jet is a retrofit device marketed by Ed Almquist. It is designed to bleed in extra air to the engine by allowing ambient air to bypass the carburetor under high engine load conditions. The manufacturer claims the device reduces emission pollutants and improves fuel economy.

EPA has tested several PCV air bleed devices previously and disseminated the test results. However, due to the increased recent interest in fuel economy and emissions reduction by the public, EPA has received a large number of governmental and private inquiries about the benefits of retrofit devices. To better respond to these requests, EPA is endeavoring to perform additional tests. Therefore, in response to a request from the Federal Trade Commission, EPA conducted a series of tests on the Ram-Jet device.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving performance improvements on the many different types of vehicles that are in actual use requires a much larger sample of test vehicles than is economically feasible in the evaluation test projects conducted by EPA. For promising systems it is necessary that more extensive test programs be carried out.

The conclusions from the EPA evaluation test can be considered to be quantitatively valid only for the specific test vehicles used; however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

Summary of Findings (Test Vehicles grouped together)

Overall, the Ram-Jet device did not significantly affect the vehicle's HC emissions for either the FTP or HFET.

Overall, the Ram-Jet device did not significantly affect the vehicle's CO emissions for either the FTP or HFET. The results for individual vehicles and tests were mixed. There were small increases and decreases in CO emissions.

Overall, the Ram-Jet device did not significantly affect the vehicle's NOx emissions.

Overall, the Ram-Jet device did not significantly affect the vehicle's fuel economy. However, the Ram-Jet device tended to cause a small decrease in fuel economy for some vehicles.

Device Description

The Ram-Jet is an after-market device designed to bleed in extra air to the engine under moderate to heavy load conditions (see figure 1). The device is installed in a vehicles' PCV line. Since the carburetor PCV hose fitting is below the carburetor venturi, any flow through this line bypasses the venturi thus leaning out the air/fuel charge reaching the engine.

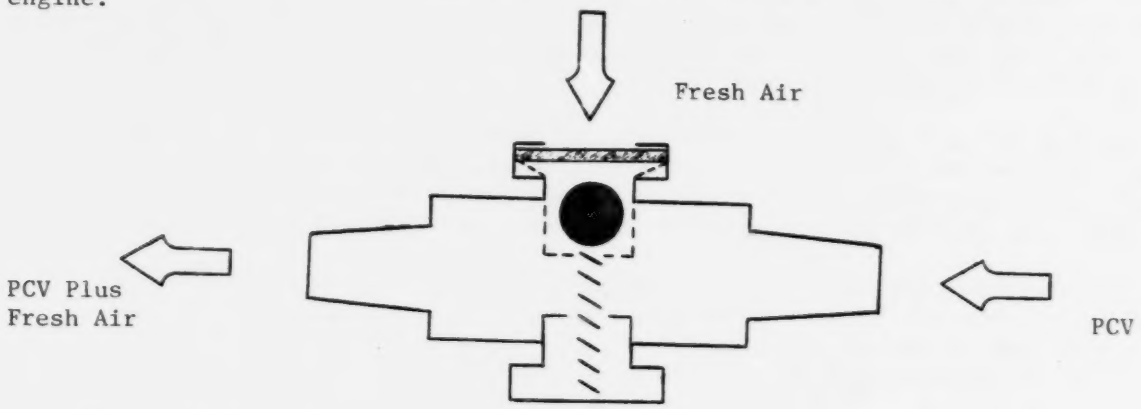


Figure 1: Cross Sectional View of the Ram-Jet

In operation, air enters the top of the Ram-Jet, is filtered, passes through an adjustable ball-and-spring type valve, and enters the PCV line. Under conditions of high manifold vacuum (i.e., idling, coasting, or cruising at moderate speeds) the ball-and-spring valve is designed to close. This prevents extra ambient air from being drawn through the Ram-Jet and into the PCV line and then to the engine below the carburetor venturi. Thus the vehicle operation should be identical to the unmodified condition. Under conditions of low manifold vacuum (i.e., accelerating, high speeds, hill climbing and pulling a load) the valve is designed to open. This allows extra ambient air to enter the intake system below the carburetor venturi thus leaning out the carburetor fuel/air mixture.

The manufacturer claims the following benefits for his device:

- -reduced HC, CO and NOx emissions
- -increased fuel economy
- -better engine performance
- -reduction in combustion chamber deposits
- -reclaims wasted blow by condensates
- -improves carburetion and PCV efficiency during all operating conditions whether the air valve is open or not.

The manufacturer claims these benefits are immediately obtained except for the reduction in combustion chamber deposits which only occurs gradually.

Test Vehicle Description

The three test vehicles used in this study were:

A 1979 Chevrolet Impala equipped with a 5.7 litre V-8 engine, automatic transmission and air conditioning. This vehicle used EGR and an oxidation catalyst for emission control.

A 1979 Chrysler LeBaron equipped with a 318 CID Lean Burn V-8 engine, automatic transmisssion and air conditioning. This vehicle was equipped with EGR and an oxidation catalyst for emission control.

A 1975 Dodge Dart equipped with a 225 cubic inch inline 6-cylinder engine and an automatic transmission. This vehicle was calibrated to meet the 1975 California emission standards. This vehicle used an air pump, EGR, and an oxidation catalyst for emission control.

A complete description of these vehicles is given in the test vehicle description in Appendix A.

Test Procedure

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP) described in the Federal Register of June 28, 1977 and the EPA Highway Fuel Economy Test (HFET) described in the Federal Register of September 10, 1976. The vehicles were not tested for evaporative emissions.

Prior to baseline testing, each vehicle was give a specification check and inspection. The ignition timing, idle speed, and fast idle speed were checked for agreement with the manufacturer's specifications given on the Vehicle Emission Control Information label affixed to the engine compartment. Each vehicle met its manufacturer's specification and therefore no adjustments were required.

The vehicles were inspected for engine vacuum leaks, proper connection of vacuum hoses, functioning PCV valve, oil and water levels and general condition of engine compartment. Each vehicle was in satisfactory condition when initially inspected.

The vehicles were tested in the baseline (stock) configuration and with the device installed. At each test condition, a minimum of two FTP and HFET tests were conducted.

For tests with the Ram-Jet installed, the device was adjusted per the device manufacturer's instructions so that it closed at idle and opened at moderate loads.

Test Results

The objective of this test program was to determine if the Ram-Jet caused a significant beneficial change in vehicle emissions or fuel economy.

The test results are summarized in Tables I and II below. The results of individual tests are given in Tables III and IV in the appendix.

Table I
FTP Mass Emissions
grams per mile

Test Condition	HC	CO	CO_2	NOx	MPG
Chevrolet Impala					
Baseline Avg. (3 tests)	0.63	4.80	565	1.27	15.5
Ram-Jet Avg. (2 tests)	0.61	3.96	581	1.19	15.0
Chrysler LeBaron					
Baseline Avg. (3 tests)	0.77	8.47	566	1.30	15.2
Ram-Jet Avg. (2 tests)	0.68	7.48	577	1.46	15.0
Dodge Dart					
Baseline Avg. (2 tests)	0.44	6.53	550	2.05	15.8
Ram-Jet Avg. (2 tests)	0.61	6.92	551	1.93	15.7

Table II
Highway Fuel Economy Test Mass Emissions
grams per mile

Test Condition	HC	CO	CO_2	NOx	MPG
Chevrolet Impala					
Baseline Avg. (4 tests)	0.12	0.41	410	1.60	21.6
Ram-Jet Avg. (3 tests)	0.12	0.61	413	1.50	21.4
Chrysler LeBaron					
Baseline Avg. (2 tests)	0.20	1.33	392	1.35	22.5
Ram-Jet Avg. (2 tests)	0.18	0.99	390	1.40	22.6
Dodge Dart					
Baseline Avg. (2 tests)	0.05	0.21	359	3.14	24.7
Ram-Jet Avg. (2 tests)	0.05	0.08	364	2.78	24.3

1. Federal Test Procedure

The Ram-Jet device did not significantly affect the HC emissions from the Impala or the LeBaron. It did tend to increase the Dart's HC emissions.

The use of the Ram-Jet caused mixed results on CO emissions. The Impala's FTP CO emissions were significantly reduced. The LeBaron's FTP CO emissions tended to be reduced. However this change was not significant due to the test-to-test variability in the LeBaron's CO emissions. The Dart's CO emissions tended to be increased by the use of the Ram-Jet. Again this change was not significant due to the variability in the Dart's CO emissions.

The use of the Ram-Jet caused no significant change in NOx emissions for the FTP. The Impala's emissions were not affected by the use of the Ram-Jet. The LeBaron's NOx emissions tended to be increased. The Dart's NOx emissions tended to be decreased.

The Ram-Jet did not significantly affect the vehicle's fuel economy. The device did tend to cause a small loss in fuel economy for the Impala and LeBaron.

2. Highway Fuel Economy Test

The HC emissions on all three vehicles were low both with and without the Ram-Jet. The HFET HC emission results were identical.

Again, the Ram-Jet caused mixed results on CO emissions. The Impala's HFET CO emissions tended to increase with the use of the device. The LeBaron's and Dart's HFET CO emissions were significantly reduced by the Ram-Jet.

On one baseline test, the Dart's NOx emissions were appreciably higher. However, overall, all three vehicles' HFET NOx emissions and fuel economy were not significantly affected by the use of Ram-Jet.

3. Other

On one FTP and one HFET, the LeBaron ran roughly when the Ram-Jet device was installed. The Dart stalled on one baseline test. There were no other noticeable changes in vehicle performance.

Discussion of Vehicle operating and maintenance tips furnished with Ram-Jet

The Ram-Jet installation instructions contain numerous tips to help the driver increase fuel economy. They can be classified into two broad categories-careful driving habits and vehicle maintenance. The instructions also note that due to variability in the operator's usage of a vehicle, fuel economy should be averaged over at least ten tankfuls of gasoline (about 2500-3000 miles).

A driver who conscientiously follows the careful driving habit recommendations and tune-up suggestions should notice a significant improvement in vehicle fuel economy. Drivers who bought the Ram-Jet to improve fuel economy would be expected to follow these suggestions. They would therefore, be expected to note a significant improvement in fuel economy which they might tend to attribute to the device. However, for a driver to properly determine the benefits of the Ram-Jet, the driver would first have to drive without the device (after just purchasing Ram-Jet) and then with the device, using the same driving and vehicle maintenance procedures.

Many users would be unwilling to delay usage for so long. And therefore the driver would have a built in bias for believing that the device improved fuel economy.

Conclusions

Overall the Ram-Jet showed no significant beneficial change in the test vehicles' emissions or fuel economy. HC emissions were generally unaffected by the device. CO emission results were mixed. There were small increases and decreases in CO emissions caused by the device. NOx emissions were unaffected by the use of Ram-Jet.

Fuel economy was either unaffected or tended to decrease with the use of the Ram-Jet.

EPA has tested several PCV air bleed devices in the past. These devices did not improve fuel economy. Small reductions in HC or CO emissions and small increases in NOx emissions occurred in some of these tests. However, these same effects can be achieved through carburetor enleanment and ignition retard. For most vehicles, these are simple adjustments. The Ram-Jet PCV air bleed did not exhibit any significant change in this trend.

Appendix

TEST VEHICLE DESCRIPTION

Chassis model year/make-1979 Chevrolet Impala
Vehicle I.D. 1L47L9S115799

Engine

type	Otto Spark, V-8
bore x stroke	4.00 x 3.48 in/101.6 x 88.4 mm
displacement	350 CID/5.7 liter
compression ratio	8.3:1
maximum power @ rpm	170 hp/ 126 k W
fuel metering	4 venturi carburetor
fuel requirement	Unleaded, tested with indolene HO unleaded

Drive Train

transmission type	3 speed automatic
final drive ratio	2.41

Chassis

type	2 door sedan
tire size	FR 78 x15
curb weight	3840 lb/1742 bg
inertia weight	4000 lb.
passenger capacity	6

Emission Control System

basic type	EGR Oxidation Catalyst

Appendix A
TEST VEHICLE DESCRIPTION
Chassis model year/make-1979 Chrysler LeBaron
Vehicle I.D. FM41G9F150932

Engine

type	Otto Spark, V-8
bore x stroke	3.91 x 3.31 in/99.3 x 84.1 mm
displacement	318 CID/5211 CC
compression ratio	8.61:1
maximum power @ rpm	145 hp/108 k W
fuel metering	2 Venturi carburetor
fuel requirement	Unleaded, tested with indolene HO unleaded

Drive Train

transmission type	3 speed lockup automatic
final drive ratio	2.50

Chassis

type	4 door sedan
tire size	FR 78 X 15
curb weight	3660 lb./1660 kg
inertia weight	4000 lb.
passenger capacity	6

Emission Control System

basic type	EGR Oxidation catalyst

Appendix

TEST VEHICLE DESCRIPTION

Chassis model year/make-1975 Dodge Dart
Emission Control System-Air Pump, Catalyst EGR
Vehicle I.D. LH41C5B290359

Engine

type	Inline 6, 4 cycle
bore x stroke	3.40 X 4.125 in.
displacement	225 CID/3687 cc
compression ratio	8.4:1
fuel metering	1 Venturi, carburetor
fuel requirement	unleaded, tested with Indolene HO unleaded

Drive Train

transmission type	3 speed automatic
final drive ratio	2.75

Chassis

type	4 door sedan
tire size	D78 X 14
inertia weight	3500 lbs.
passenger capacity	6

Emission Control System

basic type	air pump oxidation catalyst EGR calibrated to 1975 California standards

Table III
FTP Mass Emissions
grams per mile

Test Condition	Test#	HC	CO	CO_2	NOx	MPG
Chevrolet Impala						
Baseline	80-0573	.72	4.85	569	1.29	15.3
Baseline	80-0575	.59	4.54	565	1.29	15.5
Baseline	80-0446	.58	5.01	560	1.23	15.6
Ram-Jet	80-0442	.66	4.12	586	1.20	14.9
Ram-Jet	80-0443	.56	3.80	575	1.17	15.2
Chrysler LeBaron						
Baseline	80-0585	.74	5.86	567	1.34	15.3
Baseline	80-0556	.69	9.51	575	1.31	15.0
Baseline	80-0587	.87	10.05	557	1.24	15.4
Ram-Jet	80-0552	.64	6.62	577	1.57	15.0
Ram-Jet	80-0554	.72	8.33	577	1.35	15.0
Dodge Dart						
Baseline	80-0246	.38	6.06	547	1.99	15.9
Baseline	80-0735	.50	7.00	553	2.11	15.7
Ram-Jet	80-0292	.66	7.25	550	1.86	15.7
Ram-Jet	80-0294	.55	6.59	552	2.00	15.7

Table IV
Highway Fuel Economy Test Mass Emissions
grams per mile

Test Condition	Test#	HC	CO	CO_2	NOx	MPG
Chevrolet Impala						
Baseline	80-0438	.13	.46	399	1.57	22.2
Baseline	80-0574	.13	.29	415	1.60	21.3
Baseline	80-0445	.11	.35	422	1.67	21.0
Baseline	80-0886	.10	.54	402	1.55	22.0
Ram-Jet	80-0439	.12	.69	415	1.52	21.3
Ram-Jet	80-0441	.12	.72	410	1.51	21.6
Ram-Jet	80-0444	.11	.42	414	1.47	21.4
Chrysler LeBaron						
Baseline	80-0586	.20	1.40	396	1.34	22.2
Baseline	80-0557	.19	1.26	387	1.35	22.8
Ram-Jet	80-0553	.17	.76	388	1.40	22.8
Ram-Jet	80-0555	.18	1.22	392	1.40	22.5
Dodge Dart						
Baseline	80-0316	.05	.19	356	2.79	24.9
Baseline	80-0734	.06	.22	362	3.48	24.5
Ram-Jet	80-0293	.05	.08	367	2.79	24.2
Ram-Jet	80-0295	.05	.08	361	2.76	24.6

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980- 651-112/0214